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Axionic extension of the Einstein-aether theory

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Abstract

© 2016 American Physical Society.We extend the Einstein-aether theory to take into account the interaction between a pseudoscalar field, which describes the axionic dark matter, and a timelike dynamic unit vector field, which characterizes the velocity of the aether motion. The Lagrangian of the Einstein-aether-axion theory includes cross terms based on the axion field and its gradient four-vector, on the covariant derivative of the aether velocity four-vector, and on the Riemann tensor and its convolutions. We follow the principles of the effective field theory, and include in the Lagrangian of interactions all possible terms up to the second order in the covariant derivative. The interpretation of new couplings is given in terms of irreducible parts of the covariant derivative of the aether velocity - namely, the acceleration four-vector, the shear and vorticity tensors, and the expansion scalar. A spatially isotropic and homogeneous cosmological model with a dynamic unit vector field and axionic dark matter is considered as an application of the established theory; new exact solutions are discussed, which describe models with big rip, pseudo-rip, and de Sitter-type asymptotic behavior.

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